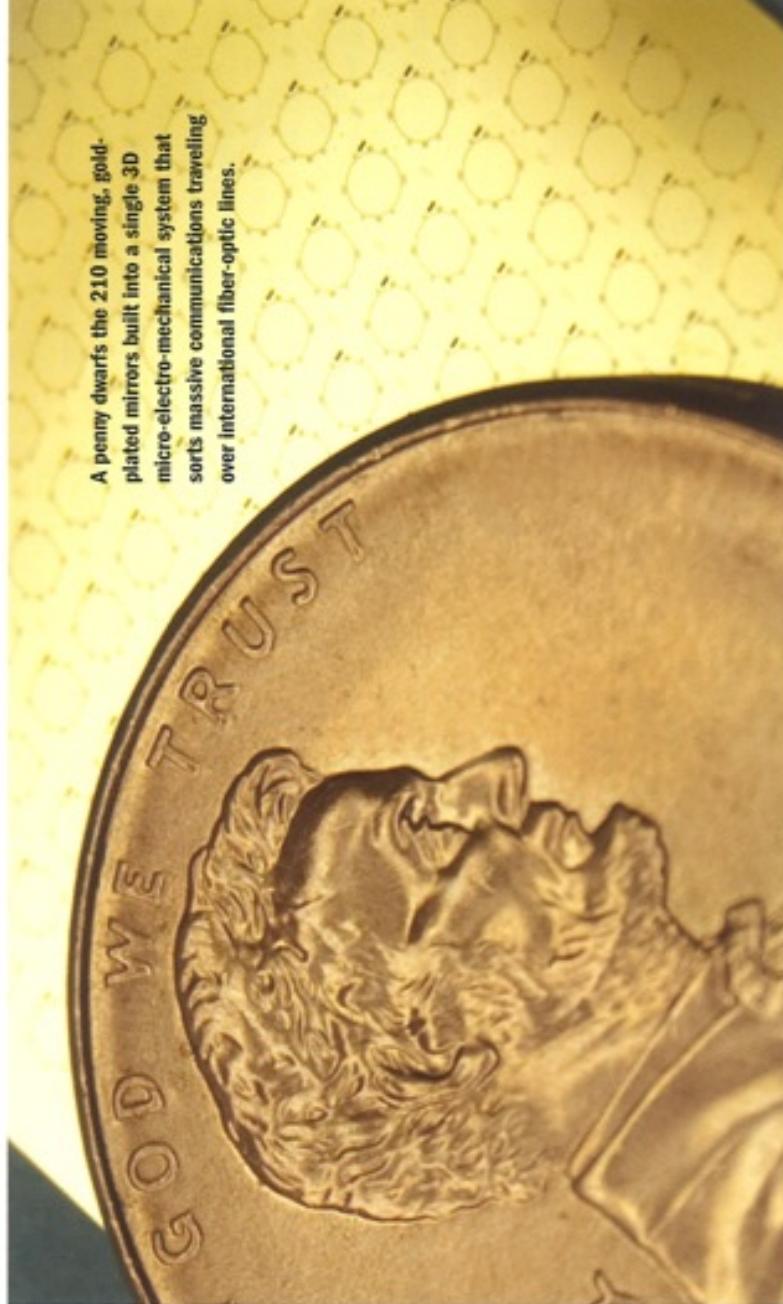


Discussion are underway concerning putting fiber optics into such aircraft as the Navy's EP-3E and its yet-to-be-named replacement. Officials in the Navy's new P-8 patrol aircraft program are considering fiber optics for the mission systems. The Army's difficulties in fielding an Airborne Common Sensor for signals and imagery intelligence was triggered by a requirement for too much equipment without sufficient power and cooling. Fiber optics are viewed as part of the solution

to outfitting smaller intelligence-gathering aircraft with the needed sensors. They also are expected to be in most proposals for a large National Cyber Range. The Defense Advanced Research Projects Agency is looking at remote sites in China Lake, Calif., Holloman AFB, N.M., and perhaps Texas. There also is a large investment in fiber at the National Security Agency at Ft. Gordon, Ga.

A penny dwarfs the 210 moving, gold-plated mirrors built into a single 3D micro-electro-mechanical system that sorts massive communications traveling over international fiber-optic lines.



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Electronic Blitz

Intelligence ops are poised to gather, move and analyze more information than ever before

DAVID A. FULGHUM/WASHINGTON

intelligence agencies and military cyber-commanders are at the tipping point in their switch from surveillance at the speed of electricity to combat at the speed of light, and parsing messages sent via high-volume fiber optics is a key to this transformation.

Agencies and national governments have an acute interest in monitoring fiber-optic communications, which are growing at the rate of about 20% per year, intelligence officials say. But turning those nearly speed-of-light messages into electric signals, sorting them and then re-converting them to light, has become a time and cost impossibility.

The demand to wet more communications for illegal or potentially deadly messages remains insatiable, however. So the pressure is on to find new science to meet cyber-intelligence needs.

"As optical and cloud computing are introduced, all of a sudden there is a new [flexibility to] where processing can be done," says Lt. Gen. William Lord, the U.S. Air Force's chief information officer. "It changes the way you go after a problem, certainly. I don't see the way people look for, move and dissect the information changing for a long while. But we will have to do it faster."

"What that [desire for additional speed] drives is the need to do [more intelligence analysis and cyber forensics] in the same place even if the people involved are from different organizations," Lord says. "All of a sudden, it's not so much about organization as it is about where [experts, analysts and specialists] come together. . . . Maybe it's even virtual teams that are tied together with social network sites."

So a major breakthrough in tapping into messages sent via high-volume fiber optics will be discovering how to use optics to manage light. One company—Glimmerglass—believes it has an answer to some of cyberspace's acceleration problems. Company researchers use three-dimensional micro-electro-

mechanical systems (3D MEMS) technology, patented algorithm controls and tiny mirrors—that relay hundreds of light streams—to sort and distribute light-borne communication signals.

A small, 1.5 X 3 X 3-in. switching engine, for example, manages optical signal paths between 192 input/output, high-density optical fibers, eliminating the need for about 190 electrical conversations. The signals are monitored by photo detectors as they come into the switch. These, in turn, are directed onto a 3D MEMS array embedded with hundreds of 1-mm.-wide micro-mirrors.

"This very exotic lens array can be focused so each beam is pointed toward a different mirror," says Glimmerglass President/CEO Robert Lundy. "The MEMS micro-mirror array is [etched into] single-crystal silicon. Each mirror is covered in a gold overlay, is deep-well etched, frictionless and floats on four 3-micron metallic springs. Mirrors can be moved as much as 4.6 deg. to point at a bounce mirror that can direct its beam to any other mirror on the same array. In addition, they can all 'talk' to each other."

"There are also requirements to capture ultra-low levels of light pulled from optical signals.

"For example, we have been selling to one of the major [aerospace industry] integrators for four years," Lundy reveals. "It started during meetings with one of the international agencies. They asked us how to manage -40dBm light [a tiny power measurement]. That's like a photon per fortnight—an almost impossible perception of an optical signal. It is some thousandths of the original signal. We showed that we could monitor, connect and switch it. Most of [our] 17 patents are associated with the array design, the MEMS design and the control system," Lundy says.

The device passes incoming beams through an array of optical lenses that focus them onto a corresponding array of

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Glimmerglass
Networks

210 1-mm-wide articulating mirrors. The mirrors, managed remotely through software, then bounce the beams to selected output fibers to be distributed to processing locations and analysts. Signals also can be optically split into multiple perfect copies and each copy connected to a separate output for even wider distribution.

Varying the voltage of three electro-static probes underneath each mirror produces the proper tilt. The ceramic substrate, lens array and housing are thermally matched to reduce stress during temperature variations.

"The magic is in keeping the temperature stable and the mean time between failures high," Landy says. "Right now, it's about 16 years."

A feedback loop starts from the device's output. The optical signal goes through a photo-detector that keeps track of the power level, which is monitored by software. The mirrors are dynamic—always in motion—so the control system compensates for the resulting thermal changes or shock.

"We are just now starting to look on the other side of the [intelligence] veil to find out what they really need," Landy says. We're the optical signal management system that allows the agencies to create, monitor and reconfigure light paths very dynamically."

Analysts are expressing relief at having equipment that eliminates a lot of manual activity.

"So if the equipment was located in a little room halfway around the world," says Keith May, Glimmerglass's director of business development, "they would text a guy, ask him to move cable A into slot B. That's how they did business before. Now they can sit [in a location near Washington] and click once for an input and once again for an output [to disseminate] material to analysts anywhere."

But the new reality is a volume of message traffic that confounds the imagination. In fact, the latest Glimmerglass orders are contingent on providing a capability to look remotely at hundreds of locations and monitor them.

Fiber-optic landing stations, perhaps several, are on the coasts of major countries. Fiber-optic cables come out of the Atlantic in New Jersey, the Baltic in Stockholm or via the Suez Canal into Cairo. In terms of communications, fiber optics are sweeping the globe. About 95% of the world's international communications traffic is carried by fiber optics, and most of that goes under the sea.

"We believe our 3D MEMS technology—as used by governments and various agencies—is involved in the collection of intelligence from sensors, satellites and undersea fiber systems," May says. "We are deployed in several countries that are using it for lawful interception. They've passed laws, publicly known, that they will monitor all international traffic for interdiction of any kind of terrorist activity. With that

they need to select the wavelengths they want to look at, de-multiplex the signals and then selectively send them places for processing and monitoring."

The big problem is how to rapidly monitor all the communications moving on light signals. There are millions of miles of undersea cable. Each cable typically contains 4-8 fibers and each fiber carries 40-160 separate light wave signals—each handling 10-40 gigabits of traffic. But there are a few shortcuts to selecting from the massive inflow; looking for signals on the light source is one—no signals, no worries. If the fiber is dark, there are no data traveling. You can also play the percentages.

"I have a line coming from Yemen, I'm always going to be monitoring that," May says. "But Sweden—not so much. Then it comes down to processing." There, another set of requirements kicks in—speed of transmission, low transmission signal loss, small equipment size and low power needs.

"The proliferation of optical signals in the tactical and strategic arenas is a given," Landy says. "It's happening. There is more fiber just because of the capacity. So any place there is

"The magic is in keeping the temperature stable and mean time between failures high. Now it's about 16 years."

Optical has a lot

cause it is noise or vulnerable to intense electrical

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Moreover, the fiber

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Also, there is great potential for developing

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will be a network on the platform that car

flows of information optically. Optical mana

on the platform will help select the traffic i

onto narrower radio links."

It's not quite "all done with mirrors," but the flow via millions of miles of undersea fiber-optic cable and very, very fast.

